CMAJ OPEN
MEDICAL RESEARCH FOR ALL

The effect of the Fort McMurray wildfires on the health of evacuated workers: follow-up of two cohorts.

Journal:	*CMAJ Open*
Manuscript ID	CMAJOpen-2017-0047
Manuscript Type:	Cohort (prospective)
Date Submitted by the Author:	02-Apr-2017
Complete List of Authors:	Cherry, Nicola; University of Alberta, Medicine Haynes, Whitney; University of Alberta, Medicine
Keywords:	Epidemiology, Community medicine, Mental health
More Detailed Keywords:	Wildfire, Fort McMurray

Abstract:	Background: Wildfire engulfed the City of Fort McMurray on May 3rd 2016. Access to two active cohorts allowed us to rapidly assess effects on evacuated workers. Methods: Workers previously recruited for two occupational health studies completed a short questionnaire about experiences during and since the fire, 3-26 weeks after the evacuation. Results: We ascertained the whereabouts on May 3rd of 129 participants: 109 were in the Fort McMurray area. One in three (34%) reported a health condition immediately post fire, including 17 respiratory and 15 mental ill-health complaints. At follow-up, mean 102 days post-fire, only 11 reported a fire-related condition including 8 of mental ill-health, 2 respiratory. No change was seen from pre-fire reports of alcohol, cigarettes, street drugs or medication. Mean scores on the Hospital Anxiety and Depression Scale, completed post-fire, were higher in those evacuated: anxiety: 6.3 evacuated, 3.4 not (p=0.005); depression: 4.1 evacuated, 2.3 not (p=0.04). 17% of those evacuated had scores indicative of moderate or severe anxiety or depression. Regression modeling showed anxiety higher in women, with longer time since the fire and with accommodation post-evacuation. Depression scores were higher in women and with financial loss due to lack of work: a quarter had not worked since the fire and less than half had yet returned to Fort McMurray. Interpretation: Although evacuation was associated with higher anxiety and depression scores, persisting ill-health post-fire was not widespread at early follow-up. While these results are encouraging, these 'heathy worker'

	results cannot be generalized to all evacuees.

The effect of the Fort McMurray wildfires on the health of evacuated workers: follow-up of two cohorts.

Nicola Cherry MDCM PhD and Whitney Haynes MPhil

Division of Preventive Medicine

University of Alberta

Corresponding author email: ncherry@ualberta.ca

Funding statement: Both cohorts are supported with funds from the OHS Futures program of the Alberta Government. The study of women in trades is funded by the Canadian Institute for Health Research (CIHR).

Neither Nicola Cherry nor Whitney Haynes has any competing interest

Abstract

Background: Wildfire engulfed the City of Fort McMurray on May 3rd 2016. Access to two active cohorts allowed us to rapidly assess effects on evacuated workers.

Methods: Workers previously recruited for two occupational health studies completed a short questionnaire about experiences during and since the fire, 3-26 weeks after the evacuation.

Results: We ascertained the whereabouts on May 3rd of 129 participants: 109 were in the Fort McMurray area. One in three (34%) reported a health condition immediately post fire, including 17 respiratory and 15 mental ill-health complaints. At follow-up, mean 102 days post-fire, only 11 reported a fire-related condition including 8 of mental ill-health, 2 respiratory. No change was seen from pre-fire reports of alcohol, cigarettes, street drugs or medication. Mean scores on the Hospital Anxiety and Depression Scale, completed post-fire, were higher in those evacuated: anxiety: 6.3 evacuated, 3.4 not (p=0.005); depression: 4.1 evacuated, 2.3 not (p=0.04). 17% of those evacuated had scores indicative of moderate or severe anxiety or depression. Regression modeling showed anxiety higher in women, with longer time since the fire and with accommodation post-evacuation. Depression scores were higher in women and with financial loss due to lack of work: a quarter had not worked since the fire and less than half had yet returned to Fort McMurray.

Interpretation: Although evacuation was associated with higher anxiety and depression scores, persisting ill-health post-fire was not widespread at early follow-up. While these results are encouraging, these 'heathy worker' results cannot be generalized to all evacuees.

Introduction

On May 3rd 2016 wildfires engulfed the city of Fort McMurray in the north of Alberta, Canada. A total evacuation of some 88,000 civilians was carried out with the loss of only 2 lives in a vehicle collision. Investigations of the effects of the fire on the local communities, the environment and on first responders have recently been funded through the Canadian Institutes for Health Research.

We report here a study of workers recruited before the fire to two cohorts, one of work injuries in the Fort McMurray/Wood Buffalo area (referred to below as Fort McMurray) and the other of men and women in the welding and electrical trades in high demand in the oil fields, for which Fort McMurray is the hub. Many workers come to the region from across Canada because of the opportunity to earn high wages. Some continue to commute back to families elsewhere while many come to regard Fort McMurray as home. The effect of the fire and evacuation on these workers, on whom the prosperity of the region depends, is not the focus of any of the recently funded studies, but our existing cohorts, although small, provided a unique opportunity to assess rapidly the early effects of the fire. The chance existence of a pre-existing cohort, as with the Canterbury earthquakes [1], provides a powerful research design that minimises bias. The sample is selected before residents are widely dispersed; the decision to take part is independent of health status post event; commitment to the research before the disaster enhances participation; collection of pre-event health indicators facilitates analysis of change and susceptibility.

The members of our cohorts do not represent everyone in the Fort McMurray area on May 3rd but together they are a sample, not biased by events since the fire, of both the settled and more transient workers whose lives have been dislocated. We wanted to know if the fire had affected their mental or physical health, and if so, whether these effects had been mitigated or exacerbated by events at the time of evacuation or in the following days and weeks.

Methods

Study participants

Injury cohort: To be eligible a worker had to be employed in Fort McMurray: further details of cohort recruitment are given in Appendix 1. The design was to follow-up 4 months after recruitment to collect information about injuries. Participants were recruited 14th October 2015-April 29th 2016. Thus cohort recruitment had been completed 4 days before the fire.

Trade cohort: In this on-going cohort of welding and electrical trades across Canada, participants complete a baseline questionnaire at recruitment (in 2011-2015) and are followed-up every six months to determine health and exposure (Appendix 1)[2]. We emailed all cohort members immediately post-fire and invited them to contact us if they had been based in Fort McMurray.

Data collection

In both cohorts we had collected demographic, health and substance use information before the fire. Post- fire, participants were asked to complete, by telephone or on-line, an additional questionnaire focused on events and health during and since the fire.

For the *injury cohort*, those who had already completed the 4 month follow-up were invited to complete a supplementary post-fire questionnaire (Appendix 2). Those who had not completed the follow-up questionnaire by May 3rd answered both the injury and post-fire questions at the time dictated by the injury study protocol. Post-fire questionnaires were completed 22nd May -30th October 2016.

For the *trade cohort*, post-fire information was collected by telephone 4-24 weeks post May 3rd. The depression and anxiety scales, as outcome variables in the trades study, were not included.

Outcome variables were: self-reported health problems 'during or immediately after' the fire (Question 6.5 Appendix 2) and at follow-up, 'now' (question 6.5.2.1, Appendix 2); changes from pre-fire data on use of alcohol, tobacco, street drugs or physician prescribed medication; for the injury

cohort, scores on the anxiety and depression scales of the Hospital Anxiety and Depression Scale (HADS), a widely used 14 item questionnaire found to perform well in screening for 'caseness' [3].

Demographic factors pre-fire: sex; age; occupation (skilled/other); permanent home in Fort McMurray; partner and/or children.

Health pre-fire: medications (and why taken) in the previous week.

Events at the time of the fire: presence in Fort McMurray; evacuation; direction (north/south); sleeping arrangements ('where did you sleep during the first couple of days').

Events since the fire: damage to own neighbourhood; financial loss (property damage/ lack of work); resumption of paid employment; residence in Fort McMurray at follow-up.

Statistical analysis

Demographic, health, event and outcome data were tabulated and use of medication, tobacco, alcohol and street drugs pre and post fire compared. Differences in mean anxiety and depression scores in those evacuated or not were evaluated by analysis of variance and the proportions with moderate or high scores (using the cut-points recommended in the HADS manual) calculated. The determinants of anxiety and depression were examined by computing mean HADS scores for each demographic, fire related and post-fire factor. All with a difference between categories likely to arise by chance with $p<0.10$ were retained and entered into multivariable regression models with anxiety and depression scores as the dependent variables. The final model for each scale was determined by a forward stepwise model in which variables were entered sequentially after allowance for more strongly related variables.

Results

130 participants completed the post fire questionnaire, 114 of the 151 recruited for the injury cohort and 16 from the trade cohort. Of these 109 (95 injury: 14 trade) were present in Fort McMurray on May 3rd. One whose whereabouts were unclear was excluded.

The demographic characteristics of the participants are shown in Table 1A. The two cohorts were very similar on age and sex. Less than 1 in 5 in the trade cohort had established their home in the city, while in the injury cohort two thirds had done so.

Experience at, and since, the time of the fire.

All but 6 (5 living in a camp outside the immediate fire zone and one first responder) were evacuated (Table 1B). Two thirds of those evacuated went immediately south, towards major connurbations. Few reception centres were operating and people slept in their vehicle, in recreational vehicles, found motel rooms or went to friends and family. About one in five were evacuated to work camps north of Fort McMurray while a few made their way to their own home.

Close to 20% in the study reported that there had been damage to their own neighbourhood in Fort McMurray: a further 7% did not yet know (Table 1C). Similar numbers reported financial loss from property damage. More than half (70/130) reported financial loss from lack of work. One in four had not held paid work since the fire and less than half had returned to Fort McMurray (although 90% planned to do so).

Health effects

Among those in Fort McMurray on May 3rd one in three (37/109) reported their health had been affected during or immediately after the fire, with respiratory symptoms (N=17) reported most frequently, with 15 reports of mental ill-health (Table 2). Half (3/6) of those not evacuated reported respiratory symptoms at the time of the fire, but mental ill-health was reported only by those evacuated. At follow-up the number with health issues attributed to the fire had decreased to 10% (11/109) with mental ill-health now reported more frequently than respiratory symptoms.

Thirty eight recorded in their most recent pre-fire questionnaire that they had taken medication during the previous week. Twelve were taking medication for chronic disease. Three of the 7 taking

medication for asthma and/or mental ill-health pre-fire had persistent health problems at follow-up (42.9%), a higher proportion (p=0.02) than the 8/102 (7.8%) not taking medication for either of these conditions.

There was no increase in the numbers taking medication post fire, when only 35/109 listed any medication.

No change was seen in the use of alcohol or cigarettes for the 89 evacuated participants with these data. For alcohol, 55 drank in the last month pre-fire and 53 post-fire: mean numbers of units/week were 5.5 before, 5.3 after. Thirty smoked pre-fire and 31 post-fire with mean numbers of cigarettes/day 12.6 before, 12.9 after. For the 73 with information on street drugs (not collected in the trade cohort) 11 reported street drugs pre-fire, 7 post-fire.

Anxiety and Depression

We investigated the relationship between anxiety and depression on the HADS questionnaire and events at the time of, and since, the fire. First we compared scores for the 90 respondent evacuated from Fort McMurray with the 22 in the injury cohort either not evacuated or not in Fort McMurray on May 3rd (Table 3A). Those evacuated had significantly higher mean anxiety and depression scores than those not. Of those evacuated 16.7% (15/90) had scores suggestive of moderate or severe anxiety or depression at follow-up (Table 3B). None of the 22 not evacuated had a moderate or severe score on either scale.

Mean anxiety and depression scores were computed for each of the factors shown in Tables 1-2. Where the probability of a difference between means arising by chance was <0.10, the means scores for the factor are shown in Table 4. From Table 1A only sex met this criterion, with anxiety and depression scores higher in women: age, marital status and children did not. Among the factors in Table 1B, only sleeping after the evacuation at a reception centre or motel was related to greater anxiety. Participants also had higher mean anxiety scores if their neighbourhood had been damaged

by the fire (or if this was still uncertain), if they had financial loss from lack of work or if they reported health problems immediately after the fire. Depression met the criterion only for sex and financial loss from lack of work. The time between the fire and the date of questionnaire completion is also shown, with anxiety being higher (though not reaching the criterion of statistical significance) for those whose questionnaire was completed more than 3 months after the fire.

When the variables in Table 4 were all entered into a single multiple regression model (Table 5A) only three factors, being female, evacuated to a motel and time lapse since the fire, appeared to be independently related to anxiety. Depression was related only to being female and to financial loss. These factors were confirmed in the final models (Table 5 B).

Interpretation

In this cohort of workers in the Fort McMurray area there was only limited evidence of sustained mental or physical ill-health attributed to the fire at early follow-up (mean 102 days in those evacuated). Among those who recalled immediate health effects of the fire, mental ill-health was more likely than respiratory symptoms to still be present at follow-up. Only small numbers were taking medication for mental ill-health or asthma pre-fire, but these were more likely to have symptoms at follow-up. There was no evidence post-fire of increased use of alcohol, tobacco or street drugs, or greater use of prescribed medication. Nevertheless, those who had been evacuated on May 3rd had significantly higher levels of anxiety and depression than those not evacuated. Anxiety was greater in those completing the questionnaire more recently, having allowed for sex (with women more anxious) and accommodation at evacuation. Depression, also higher in women, reflected financial loss from lack of work.

In putting these results into context it must be recalled that the people living and working in the Fort McMurray area were rapidly evacuated, and that although the density of the smoke and the proximity and ferocity of the fire was terrifying to many, the acute exposure was time limited: people evacuated were out of the fire zone within 24 hours. As such, any effects on the respiratory

system might be expected to be transitory, and be largely exacerbations of pre-existing conditions [4].The effects on mental health would be expected to reflect both the stresses of the evacuation itself and events since. Reviews of earlier studies have concluded that the great majority of people exposed to natural catastrophes are resilient [5] [6] [7]. For example, 2-4 years after the Australian Black Sunday wildfires in Victoria, Australia, in which there were 173 fatalities and massive infrastructure disruption, even in the worst affected area fewer than 1 in 4 were found to have indicators of psychological distress [8]. The observed low proportions with moderate or severe anxiety or depression in the current study are in line with this. However the follow-up in this study may have been too early to reflect the full extent of disturbance. Mean anxiety scores were higher in those interviewed more than 3 months since the fire and previous studies suggest that primary referrals for psychological disturbance may peak towards the end of the first year after the event [9]: post-traumatic stress disorder (PTSD) may have a delayed onset or increase in severity over time [10]. Data are available on physician visits throughout Alberta for all those (not simply workers) normally resident in Fort McMurray [11]. Comparing the first week in December 2015 (pre-fire) with the same week in 2016 (9 months post-fire) physician visits for anxiety increased by 14%, for depression by 28%, while visits for substance use disorder decreased markedly. In our data there was also no increase in substance use although this might have been expected [12]. We did not find studies that systematically examined the effects on later ill-health of logistic arrangements during the evacuation, although family separation has been identified as an important stressor [13]. In the present study those accommodated in motels initially were largely long term residents of Fort McMurray who did not find accommodation with family or friends: the motel may well have been only the first stage in a longer period of unsettled housing.

The participants in this study were all employed: hey were generally fit and few had chronic ill-health. As such their resilience may be greater than other civilians involved in the evacuation, and we cannot generalise these results to those not in paid employment, to other age groups or to first responders. Even among the employed some will have been under-represented: the methods of

recruitment would have effectively excluded those working within the indigenous communities and permanent employees of large companies may have had different experiences post-fire than those in more precarious work. A further limitation is that our conclusion that the evacuation increased both anxiety and depression rests on comparison with the scores of those who by chance or choice were not in the area of the fire on May 3rd.

The conclusions from this study are guardedly optimistic. Although some may need support for mental ill-health going forward, the results of this and earlier studies suggest that most of these workers will successfully re-establish their lives, with the great majority hoping to return to work in the Fort McMurray area. Financial loss from lack of work was the major cause of depression and for these workers an upturn in investment and in the local economy is probably the one factor most likely to support recovery.

References.

1. Fergusson D M, Horwood L J, Boden JM, Mulder RT. Impact of a major disaster on the mental health of a well-studied cohort. JAMA Psychiatry 2014; 71: 1025-1031.
2. Arrandale VH, Beach J, Cembrowski GS, Cherry NM. Urinary metal concentrations among female welders. Ann Occup Hyg 2015; 59: 52-61
3. Bjelland I, Dahl AA, Haug TT, Neckelmann D. The validity of the Hospital Anxiety and Depression Scale: an updated literature review. Journal of Psychosomatic Research. 2002; 52: 69-77.
4. Reid CE, Brauer M, Johnston FH, Jerrett M, Balmes JR, Elliot CT. Critical review of health impacts of wildfire smoke exposure. EHP. 2016; 124:1334-1343.
5. Fergusson DM. Boden JM. The psychological impacts of major disasters Australia and New Zealand Journal of Psychiatry 2014; 48: 597-599
6. Norris FH, Friedman MJ, Watson PJ, Byrne CM, BDiaz E, Kaniansty K. 60,000 Disaster victims speak: Part 1. An empirical review of the empirical literature, 1981-2001. Psychiatry; 65: 207-239.
7. Neria Y, Nandi A, Galea S Post-traumatic stress disorder following disasters: a systematic review. Psychological Medicine. 2008;38:467-480.
8. Bryant RA, Waters E, Gibbs L, Gallagher HC, Pattison P, Lusher D, MacDougall C, Harms L, Block K, Snowdon E, Sinnott V, Ireton G, Richardson J, Forbes D. Psychological outcomes following the Victorian Black Saturday bushfires. Australia and New Zealand Journal of Psychiatry. 2014; 48: 634-643.
9. Reifels L, Bassilios B, Spittal MJ, King K, Fletcher J Pirkis J. Patterns and predictors of primary mental health service use following bushfire and flood disasters. Disaster Medicine and Public Health Preparedness. 2015; 9: 275-282.
10. Utzon-Frank N Breinegaard N Bertelsen M Borritz M Eller NH, Nordentoft M Olesen K, Rod NH, Rugulies R, Bonde JP. Occurrence of delayed-onset post-traumatic stress disorder: a systematic review and meta-analysis of prospective studies. Scan J Work Environ Health 2014; 40: 215-229.
11. www.ahw.gov.ab.ca/IHDA
12. Vlahov D, Galea S, Resnick H, Ahern J, Boscarino JA, Bucuvalas M, Gold J Kilpatrick D. Increased use of cigarettes, alcohol and marijuana among Manhattan, New York residents after the September 11th terrorist attacks. American Journal of Epidemiology. 2002; 155: 988-996.
13. Gallagher HC, Richardson J, Forbes D, Harms, L Gibbs L, Alkemade N, MacDougall C Waters E, Block K, Lusher D, Baker E, Bryant RA. Mental health following separation in a disaster: the role of attachment. Journal of Traumatic Stress. 2016; 29: 56-64

Table 1: Demographic characteristics of the two cohorts

Demographic factors (N-130)					
Sex	N	%	Home established in Fort McMurray	N	%
Male	81	62.3	Yes	77	59.2
Female	49	37.7	No	53	40.8
Age					
≤25	21	16.2	Living as married		
26≤35	39	30.0	Yes	54	41.5
36≤45	29	22.3	No	76	58.5
46-66	41	31.5			
			One or more children		
Working in a skilled trade			Yes	50	38.5
Yes	53	46.5	No (or unknown)	80	61.5
No	61	53.5			
Events during the fire (N=109)					
Evacuated initially	N	%	Sleeping arrangements (if evacuated)	N*	%
North	30	27.5	Vehicle, RV or trailer	3	35.0
South	7	67.0	Reception centre	4	3.9
Not evacuated	6	5.5	Motel/hotel	24	23.3
			Work camp	21	20.4
			Friends/family	25	24.3
			Own home	11	10.7
			Other only	3	3.3
			* Total N=103, multiple responses allowed		
Events since the fire (N=130)					
Damage to own neighbourhood	N	%	Financial loss from work	N	%
Yes	2	19.2	Yes	70	53.8
No	61	46.9	No	60	46.2
Not yet known	9	6.9			
Not identified with neighbourhood	35	26.9	Paid work since fire?		
			Yes	98	75.4
			No	32	24.6
Financial loss from property damage					
Yes	25	19.2	Living in Fort McMurray at follow-up		
No	76	74.6	Yes	58	44.6
Not yet known	8	7.0	No	72	55.4

Table 2: Health problems immediately after the fire and at follow-up by evacuated or not

Health problem at the time of the fire	Health problem at follow-up								
	Evacuated			Not evacuated			All		
	No problem	Problem	All	No problem	Problem	All	No problem	Problem	All
None	69	0	69	3	0	3	72	0	72
Respiratory	13	1	14	2	1	3	15	2	17
Mental health	7	8	15	0	0	0	7	8	15
Other	4	1	5	0	0	0	4	1	5
Total	93	10	103	5	1	6	98	11	109

Table 3: Anxiety or depression (HADS) scores in the injury cohort

A) Mean scores by presence in Fort McMurray at evacuation

In Fort McMurray on May 3rd		Anxiety		Depression	
	N	mean	SD	mean	SD
- Evacuated	90†	6.3	4.5	4.1	4.0
- Not	4	1.8	1.3	2.0	1.4
Based in Fort McMurray but not there May 3rd	11	3.9	3.7	2.8	2.9
No longer living/working on Fort McMurray	7	3.6	2.1	1.6	1.4
Total	112	4.4	3.9	3.7	3.8
All not evacuated	22	3.4**	2.9	2.3*	2.5
Compared to evacuated		**p=0.01		*p=0.04	

† One missing HADS score

B) Severity of scores in those evacuated

	Depression				
Anxiety	No concern 1-7	Mild 8-11	Moderate 12-14	Severe 15-30	Total
No concern 1-7	52	3	1	0	56
Mild 8-11	17	3	2	1	23
Moderate 12-14	4	1	0	1	6
Severe 15-30	1	2	1	1	5
Total	74	9	4	3	90

Table 4: Anxiety and depression for factors selected by initial screen ($p \leq 0.10$) for those in the injury cohort evacuated from Fort McMurray

			Anxiety			Depression		
		N	mean	SD	p=	mean	SD	p=
Sex	male	54	5.3	4.4	0.01	3.4	3.7	0.04
	female	36	7.8	5.2		5.2	5.2	
First evacuation nights:								
- reception centre	yes	4	10.3	6.2	0.07	5.5	7.1	0.48
	no	86	6.1	4.3		4.1	3.9	
- motel	yes	23	8.2	5.5	0.02	5.0	4.5	0.25
	no	67	5.6	3.9		3.8	3.8	
Neighbourhood damaged	yes/ unknown	27	7.5	5.7	0.10	4.9	4.7	0.24
	no	67	5.7	3.8		3.8	3.7	
Financial loss from lack of work	yes	27	7.0	4.7	0.07	4.8	4.1	0.06
	no	63	5.4	4.0		3.3	3.7	
Health problem immediately post fire	yes	30	7.6	4.3	0.06	5.0	4.0	0.13
	no	60	5.7	4.5		3.7	4.0	
Days between May 3rd at questionnaire	≤ 91 days	36	6.9	4.9	0.14	4.2	4.1	0.77
	92-182 days	54	5.4	3.7		4.0	3.9	
Overall		90	6.3	45		4.1	4.0	

Table 5: Factors related to anxiety and depression in multivariate regression models
(A) all variables entered together (B) stepwise in those evacuated (N=90)

A) All variables entered at one step

Variable	Anxiety		Depression	
	Beta	p=	Beta	p=
Male	-0.29	0.01	-0.20	0.07
Reception centre	0.12	0.22	0.04	0.73
Motel	0.25	0.01	0.09	0.43
Neighbourhood damage	0.10	0.32	0.11	0.34
Financial loss from work	0.15	0.15	0.21	0.06
Health problem post fire	0.11	0.27	0.12	0.30
> 90 days since fire	0.18	0.09	0.01	0.91

B) Variables entered stepwise with the most strongly related entered first

Variable	Anxiety		Depression	
	Beta	p=	Beta	p=
Male	-0.34	0.00	-0.21	0.04
Motel	0.31	0.00	-	-
> 90 days since fire	0.26	0.01	-	-
Financial loss from work	-	-	0.21	0.05

The effect of the Fort McMurray wildfires on the health of evacuated workers: follow-up of two cohorts.

Nicola Cherry MDCM PhD and Whitney Haynes MPhil

Division of Preventive Medicine

University of Alberta

Corresponding author email: ncherry@ualberta.ca

Funding statement: Both cohorts are supported with funds from the OHS Futures program of the Alberta Government. The study of women in trades is funded by the Canadian Institute for Health Research (CIHR).

Neither Nicola Cherry nor Whitney Haynes has any competing interest

Abstract

Background: Wildfire engulfed the City of Fort McMurray on May 3rd 2016. Access to two active cohorts allowed us to rapidly assess effects on evacuated workers.

Methods: ~~A short questionnaire about experiences during and since the fire was completed 3-26 weeks after the evacuation by workers~~ Workers previously recruited for two occupational health studies ~~of occupational health and safety~~ completed a short questionnaire about experiences during and since the fire, 3-26 weeks after the evacuation..

Results: We ascertained the w~~W~~hereabouts on May 3rd of ~~were known for~~ 129 participants: 109 were in the Fort McMurray area. One in three (34%) reported a health condition immediately post fire, including 17 respiratory and 15 mental ill-health complaints. At follow-up, mean 102 days post-fire, only 11 reported a fire-related condition including 8 of mental ill-health, 2 respiratory. No change was seen from pre-fire reports of alcohol, cigarettes, street drugs or medication. Mean scores on the Hospital Anxiety and Depression Scale, completed post-fire, were higher in those evacuated: anxiety: 6.3 evacuated, 3.4 not (p=0.005); depression: 4.1 evacuated, 2.3 not (p=0.04). 17% of those evacuated had scores indicative of moderate or severe anxiety or depression. Regression modeling showed anxiety higher in women, with longer time since the fire and with accommodation post-evacuation. Depression scores were higher in women and with financial loss due to lack of work: a quarter had not worked since the fire and less than half had yet returned to Fort McMurray.

Interpretation: Although evacuation was associated with higher anxiety and depression scores, persisting ill-health post-fire was not widespread at early follow-up. While these results are encouraging, these 'heathy worker' results cannot be generalized to all evacuees.

Introduction

On May 3rd 2016 wildfires engulfed the city of Fort McMurray in the north of Alberta, Canada. A total evacuation of some 88,000 civilians was carried out with the loss of only 2 lives in a vehicle collision. Investigations of the effects of the fire on the local communities, the environment and on first responders have recently been funded through the Canadian Institutes for Health Research ~~and the Red Cross~~.

We report here a study of workers recruited before the fire to two cohorts, one of work injuries in the Fort McMurray/Wood Buffalo area (referred to below as Fort McMurray) and the other of men and women in the welding and electrical trades in high demand in the oil fields, for which Fort McMurray is the hub. Many workers come to the region from across Canada because of the opportunity to earn high wages. Some continue to commute back to families elsewhere while many come to regard Fort McMurray as home. The effect of the fire and evacuation on these workers, on whom the prosperity of the region depends, is not the focus of any of the recently funded studies, but our existing cohorts, although small, provided a unique opportunity to assess rapidly the early effects of the fire. The chance existence of a pre-existing cohort, as with the Canterbury earthquakes [1], provides a powerful research design that minimises bias. The sample is selected before residents are widely dispersed; the decision to take part is independent of health status post event; commitment to the research before the disaster enhances participation; collection of pre-event health indicators facilitates analysis of change and susceptibility.

The members of our cohorts do not represent everyone in the Fort McMurray area on May 3rd but together they are a sample, not biased by events since the fire, of both the settled and more transient workers whose lives have been dislocated. We wanted to know if the fire had affected their mental or physical health, and if so, whether these effects had been mitigated or exacerbated by events at the time of evacuation or in the following days and weeks.

Methods

Study participants

Injury cohort: To be eligible a worker had to be employed in Fort McMurray.

: further details of cohort recruitment are given in Appendix 1. The design was to follow-up 4 months after recruitment to collect information about injuries. Participants were recruited 14th October 2015-April 29th 2016, This cohort recruitment had been completed 4 days before the fire., ~~3 days before the fire.~~

Trade cohort: In this on-going cohort of welding and electrical trades across Canada, participants complete a baseline questionnaire at recruitment (in 2011-2015) and are followed-up every six months to determine health and exposure (Appendix 1)[2]. We emailed all cohort members immediately post-fire and invited them to contact us if they had been based in Fort McMurray.

Data collection

In both cohorts we had collected demographic, health and substance use information before the fire. Post- fire, participants were asked to complete, by telephone or on-line, an additional questionnaire focused on events and health during and since the fire.

For the *injury cohort*, those who had already completed the 4 month follow-up were invited to complete a supplementary post-fire questionnaire (Appendix 2). Those who had not completed the follow-up questionnaire by May 3rd answered both the injury and post-fire questions at the time dictated by the injury study protocol. Post-fire questionnaires were completed 22nd May -30th October 2016.

For the *trade cohort*, post-fire information was collected by telephone 4-24 weeks post May 3rd. The depression and anxiety scales, as outcome variables in the trades study, were not included.

Outcome variables were: self-reported health problems 'during or immediately after' the fire (question 6.5 Appendix 2) and at follow-up, 'now'(question 6.5.2.1, Appendix 2); changes from pre-fire data on use of alcohol, tobacco, street drugs or physician prescribed medication; for the injury cohort, scores on the anxiety and depression scales of the Hospital Anxiety and Depression Scale (HADS), a widely used 14 item questionnaire found to perform well in screening for 'caseness [3].

Demographic factors ~~collected pre-fire and used in the present study were~~: sex, age, occupation (skilled/ ~~trade or~~ other); ~~, a~~ permanent home in Fort McMurray; ~~and a~~ partner and/or children.

Health pre-fire: medications ~~-~~ (and why taken) in the previous week. ~~and the conditions for which it was taken at the last pre-fire contact.~~

Events at the time of the fire ~~included~~: presence in Fort McMurray ~~on May 3rd~~; evacuation; direction ~~of the initial evacuation~~ (north/ ~~or~~ south); sleeping arrangements ('where did you sleep during the first couple of days').

Events since the fire: damage to own neighbourhood; financial loss ~~due to~~ (property damage/lack of work) ~~; financial loss due to lack of work~~; resumption of paid employment; residence in Fort McMurray at follow-up.

Statistical analysis

Demographic, health, event and outcome data were tabulated and use of medication, tobacco, alcohol and street drugs pre and post fire compared. Differences in mean anxiety and depression scores in those evacuated or not were evaluated by analysis of variance and the proportions with moderate or high scores (using the cut-points recommended in the HADS manual) calculated. The determinants of anxiety and depression were examined by computing mean HADS scores for each demographic, fire related and post-fire factor. All with a difference between categories likely to arise by chance with $p<0.10$ were retained and entered into multivariable regression models with anxiety and depression scores as the dependent variables. The final model for each scale was determined by

a forward stepwise model in which variables were entered sequentially after allowance for more strongly related variables.

Results

130 participants completed the post fire questionnaire, 114 of the 151 recruited for the injury cohort and 16 from the trade cohort. Of these 109 (95 injury: 14 trade) were present in Fort McMurray on May 3rd. One whose whereabouts were unclear was excluded.

The demographic characteristics of the participants are shown in Table 1A. The two cohorts were very similar on age and sex. Less than 1 in 5 in the trade cohort had established their home in the city, while in the injury cohort two thirds had done so.

Experience at, and since, the time of the fire.

All but 6 (5 living in a camp outside the immediate fire zone and one first responder) were evacuated (Table 1B).Two thirds of those evacuated went immediately south, towards ~~the~~ major conurbations ~~of Edmonton and Calgary, with many stopping in smaller settlements (such as Lac La Biche) along the way~~. Few reception centres were operating and people slept in their vehicle, in recreational vehicles, found motel rooms or went to friends and family. About one in five were evacuated to work camps north of Fort McMurray while a few made their way to their own home.

Close to 20% in the study reported that there had been damage to their own neighbourhood in Fort McMurray: a further 7% did not yet know (Table 1C). Similar numbers reported financial loss from property damage~~, including burnt-out vehicles and property owned by those not in the city on May 3rd. Much greater numbers~~ More than half 70/130 ~~(54%)~~ reported financial loss from lack of work. ~~At the time of follow-up o~~One in four had not held any paid work since the fire and less than half had returned to Fort McMurray (although 90% planned to do so).

Health effects

Among those in Fort McMurray on May 3rd one in three (37/109) reported their health had been affected during or immediately after the fire, with respiratory symptoms (N=17) reported most frequently, with 15 reports of mental ill-health (Table 2). Half (3/6) of those not evacuated reported respiratory symptoms at the time of the fire, but mental ill-health was reported only by those evacuated. At follow-up the number with health issues attributed to the fire had decreased to 10% (11/109) with mental ill-health now reported more frequently than respiratory symptoms.

Thirty eight recorded in their most recent pre-fire questionnaire that they had taken medication during the previous week. Twelve were taking medication for chronic disease~~, including mental ill-health (5) and asthma (3).~~ Three of the 7 taking medication for asthma and/or mental ill-health pre-fire had persistent health problems at follow-up (42.9%), a ~~significantly~~ higher proportion (p=0.02) than the 8/102 (7.8%) not taking medication for either of these conditions.

There was no increase in the numbers taking medication post fire, when only 35/109 listed any medication.

No change was seen in the use of alcohol or cigarettes for the 89 evacuated participants with these data. For alcohol, 55 drank in the last month pre-fire and 53 post-fire: mean numbers of units/week were 5.5 before, 5.3 after. Thirty smoked pre-fire and 31 post-fire with mean numbers of cigarettes/day 12.6 before, 12.9 after. For the 73 with information on street drugs (not collected in the trade cohort) 11 reported street drugs pre-fire, 7 post-fire.

Anxiety and Depression

We investigated the relationship between anxiety and depression on the HADS questionnaire and events at the time of, and since, the fire. First we compared scores for the 90 respondent evacuated from Fort McMurray with the 22 in the injury cohort either not evacuated or not in Fort McMurray on May 3rd (Table 3A). Those evacuated had~~were~~ significantly higher mean anxiety and depression

scores than those not.~~more anxious and depressed than those not.~~ Of those evacuated 16.7% (15/90) had scores suggestive of moderate or severe anxiety or depression at follow-up (Table 3B). None of the 22 not evacuated had a moderate or severe score on either scale.

Mean anxiety and depression scores were computed for each of the factors shown in Tables 1-2. Where the probability of a difference between means arising by chance was <0.10, the means scores for the factor are shown in Table 4. From Table 1A only sex met this criterion, with anxiety and depression scores higher in women: age, marital status and children did not. Among the factors in Table 1B, only sleeping after the evacuation at a reception centre or motel was related to greater anxiety. Participants also had higher mean anxiety scores if their neighbourhood had been damaged by the fire (or if this was still uncertain), if they had financial loss from lack of work or if they reported health problems immediately after the fire. Depression met the criterion only for sex and financial loss from lack of work. ~~An additional variable shown in Table 4 is t~~The time between the fire and the date of questionnaire completion is also shown, with anxiety being higher (though not reaching the criterion of statistical significance) for those whose questionnaire was completed more than 3 months after the fire.

When the variables in Table 4 were all entered into a single multiple regression model (Table 5A) only three factors, being female, evacuated to a motel and time lapse since the fire, appeared to be independently related to anxiety. Depression was related only to being female and to financial loss. These factors were confirmed in the final models (Table 5 B).

Interpretation

In this cohort of workers in the Fort McMurray area there was only limited evidence of sustained mental or physical ill-health attributed to the fire at early follow-up (mean 102 days in those evacuated). Among those who recalled immediate health effects of the fire, mental ill-health was more likely than respiratory symptoms to still be present at follow-up. Only small numbers were taking medication for mental ill-health or asthma pre-fire, but these were more likely to have

symptoms at follow-up. There was no evidence post-fire of increased use of alcohol, tobacco or street drugs, or greater use of prescribed medication. Nevertheless, those who had been evacuated on May 3rd had significantly higher levels of anxiety and depression ~~on the HADS scales~~ than those not evacuated. Anxiety was greater in those completing the questionnaire more recently, having allowed for sex (with women more anxious) and accommodation at evacuation. Depression, also higher in women, reflected financial loss from lack of work.

In putting these results into context it must be recalled that the people living and working in the Fort McMurray area were rapidly evacuated, and that although the density of the smoke and the proximity and ferocity of the fire was terrifying to many, the acute exposure was time limited: people evacuated were out of the fire zone within 24 hours. As such, any effects on the respiratory system might be expected to be transitory, and be largely exacerbations of pre-existing conditions [4].The effects on mental health would be expected to reflect both the stresses of the evacuation itself and events since. Reviews of earlier studies have concluded that the great majority of people exposed to natural catastrophes are resilient [5] [6] [7]. For example, 2-4 years after the Australian Black Sunday wildfires in Victoria, Australia, in which there were 173 fatalities and massive infrastructure disruption, even in the worst affected area fewer than 1 in 4 were found to have indicators of psychological distress [8]. The observed low proportions with moderate or severe anxiety or depression in the current study are in line with this. ~~We must bear in mind, h~~However, ~~that~~ the follow-up in this study may have been too early to reflect the full extent of disturbance. Mean anxiety scores were higher in those interviewed more than 3 months since the fire and previous studies suggest that primary referrals for psychological disturbance may peak towards the end of the first year after the event [9]: post-traumatic stress disorder (PTSD) may have a delayed onset or increase in severity over time [10]. Data are available on physician visits throughout Alberta for all those (not simply workers) normally resident in Fort McMurray [11]. Comparing the first week in December 2015 (pre-fire) with the same week in 2016 (9 months post-fire) physician visits for anxiety increased by 14%, for depression by 28%, while visits for substance use disorder

decreased markedly. In our data there was also no increase in substance use although this might have been expected [12]. We did not find studies that systematically examined the effects on later ill-health of logistic arrangements during the evacuation, although family separation has been identified as an important stressor [13]. In the present study those accommodated in motels initially were largely long term residents of Fort McMurray who did not find accommodation with family or friends: the motel may well have been only the first stage in a longer period of unsettled housing.

The participants in this study were all employed~~, many choosing to face the stresses of moving to the area to take up well-paid jobs. They~~ : they were generally fit and few had chronic ill-health. As such their resilience may be greater than other civilians involved in the evacuation, and we cannot generalise these results to those not in paid employment, to other age groups or to first responders. Even among the employed some will have been under-represented: the methods of recruitment would have effectively excluded those working within the indigenous communities and permanent employees of ~~the~~ large ~~oil and gas~~ companies may have had different ~~evacuation~~ experiences ~~and~~ post-fire employment than those in more precarious work. A further limitation is that~~, although we had some earlier health data, we did not have pre-fire HADS scores and~~ our conclusion that the evacuation increased both anxiety and depression rests on comparison with the scores of those who by chance or choice were not in the area of the fire on May 3rd.

The conclusions from this study are guardedly optimistic. Although some may need support for mental ill-health ~~The evacuation did increase anxiety and depression at this early follow-up: for some workers this may lead to longer term mental ill-health needing support~~ going forward~~,~~. ~~Nevertheless,~~ the results of this and earlier studies suggest that most of these workers will successfully re-establish their lives ~~in Fort McMurray or elsewhere.~~ With t~~T~~he great majority ~~of the~~ hoping to return to work in the Fort McMurray area.~~workers evacuated are either back in Fort McMurray or hope to return to work there.~~ Financial loss from lack of work was the major cause of

depression and for these workers an upturn in investment and in the local economy is probably the one factor most likely to support recovery.

References.

1. Fergusson D M, Horwood L J, Boden JM, Mulder RT. Impact of a major disaster on the mental health of a well-studied cohort. JAMA Psychiatry 2014; 71: 1025-1031.
2. Arrandale VH, Beach J, Cembrowski GS, Cherry NM. Urinary metal concentrations among female welders. Ann Occup Hyg 2015; 59: 52-61
3. Bjelland I, Dahl AA, Haug TT, Neckelmann D. The validity of the Hospital Anxiety and Depression Scale: an updated literature review. Journal of Psychosomatic Research. 2002; 52: 69-77.

4. Reid CE, Brauer M, Johnston FH, Jerrett M, Balmes JR, Elliot CT. Critical review of health impacts of wildfire smoke exposure. EHP. 2016; 124:1334-1343.
5. Fergusson DM. Boden JM. The psychological impacts of major disasters Australia and New Zealand Journal of Psychiatry 2014; 48: 597-599
6. Norris FH, Friedman MJ, Watson PJ, Byrne CM, BDiaz E, Kaniansty K. 60,000 Disaster victims speak: Part 1. An empirical review of the empirical literature, 1981-2001. Psychiatry; 65: 207-239.
7. Neria Y, Nandi A, Galea S Post-traumatic stress disorder following disasters: a systematic review. Psychological Medicine. 2008;38:467-480.
8. Bryant RA, Waters E, Gibbs L, Gallagher HC, Pattison P, Lusher D, MacDougall C, Harms L, Block K, Snowdon E, Sinnott V, Ireton G, Richardson J, Forbes D. Psychological outcomes following the Victorian Black Saturday bushfires. Australia and New Zealand Journal of Psychiatry. 2014; 48: 634-643.
9. Reifels L, Bassilios B, Spittal MJ, King K, Fletcher J Pirkis J. Patterns and predictors of primary mental health service use following bushfire and flood disasters. Disaster Medicine and Public Health Preparedness. 2015; 9: 275-282.
10. Utzon-Frank N Breinegaard N Bertelsen M Borritz M Eller NH, Nordentoft M Olesen K, Rod NH, Rugulies R, Bonde JP. Occurrence of delayed-onset post-traumatic stress disorder: a systematic review and meta-analysis of prospective studies. Scan J Work Environ Health 2014; 40: 215-229.
11. www.ahw.gov.ab.ca/IHDA
12. Vlahov D, Galea S, Resnick H, Ahern J, Boscarino JA, Bucuvalas M, Gold J Kilpatrick D. Increased use of cigarettes, alcohol and marijuana among Manhattan, New York residents after the September 11th terrorist attacks. American Journal of Epidemiology. 2002; 155: 988-996.
13. Gallagher HC, Richardson J, Forbes D, Harms, L Gibbs L, Alkemade N, MacDougall C Waters E, Block K, Lusher D, Baker E, Bryant RA. Mental health following separation in a disaster: the role of attachment. Journal of Traumatic Stress. 2016; 29: 56-64

Table 1: Demographic characteristics of the two cohorts

Demographic factors (N-130)					
Sex	N	%	Home established in Fort McMurray	N	%
Male	81	62.3	Yes	77	59.2
Female	49	37.7	No	53	40.8
Age					
≤25	21	16.2	Living as married		
26≤35	39	30.0	Yes	54	41.5

36≤45	29	22.3	No	76	58.5
46-66	41	31.5			
			One or more children		
Working in a skilled trade			Yes	50	38.5
Yes	53	46.5	No (or unknown)	80	61.5
No	61	53.5			

Events during the fire (N=109)

Evacuated initially	N	%
North	30	27.5
South	7	67.0
Not evacuated	6	5.5

Sleeping arrangements (if evacuated)	N*	%
Vehicle, RV or trailer	3	35.0
Reception centre	4	3.9
Motel/hotel	24	23.3
Work camp	21	20.4
Friends/family	25	24.3
Own home	11	10.7
Other only	3	3.3

* Total N=103, multiple responses allowed

Events since the fire (N=130)

Damage to own neighbourhood	N	%
Yes	2	19.2
No	61	46.9
Not yet known	9	6.9
Not identified with neighbourhood	35	26.9
Financial loss from property damage		
Yes	25	19.2
No	76	74.6
Not yet known	8	7.0

Financial loss from work	N	%
Yes	70	53.8
No	60	46.2
Paid work since fire?		
Yes	98	75.4
No	32	24.6
Living in Fort McMurray at follow-up		
Yes	58	44.6
No	72	55.4

Table 2: Health problems immediately after the fire and at follow-up by evacuated or not

Health problem at the time of the fire	Health problem at follow-up								
	Evacuated			Not evacuated			All		
	No problem	Problem	All	No problem	Problem	All	No problem	Problem	All
None	69	0	69	3	0	3	72	0	72
Respiratory	13	1	14	2	1	3	15	2	17
Mental health	7	8	15	0	0	0	7	8	15
Other	4	1	5	0	0	0	4	1	5
Total	93	10	103	5	1	6	98	11	109

Table 3: Anxiety or depression (HADS) scores in the injury cohort

A) Mean scores by presence in Fort McMurray at evacuation

In Fort McMurray on May 3rd		Anxiety		Depression	
	N	mean	SD	mean	SD
- Evacuated	90†	6.3	4.5	4.1	4.0
- Not	4	1.8	1.3	2.0	1.4
Based in Fort McMurray but not there May 3rd	11	3.9	3.7	2.8	2.9
No longer living/working on Fort McMurray	7	3.6	2.1	1.6	1.4
Total	112	4.4	3.9	3.7	3.8
All not evacuated	22	3.4**	2.9	2.3*	2.5
Compared to evacuated		**p=0.01		*p=0.04	

† One missing HADS score

B) Severity of scores in those evacuated

	Depression				
Anxiety	No concern 1-7	Mild 8-11	Moderate 12-14	Severe 15-30	Total
No concern 1-7	52	3	1	0	56
Mild 8-11	17	3	2	1	23
Moderate 12-14	4	1	0	1	6
Severe 15-30	1	2	1	1	5
Total	74	9	4	3	90

Table 4: Anxiety and depression for factors selected by initial screen ($p \leq 0.10$) for those in the injury cohort evacuated from Fort McMurray

			Anxiety			Depression		
		N	mean	SD	p=	mean	SD	p=
Sex	male	54	5.3	4.4	0.01	3.4	3.7	0.04
	female	36	7.8	5.2		5.2	5.2	
First evacuation nights:								
- reception centre	yes	4	10.3	6.2	0.07	5.5	7.1	0.48
	no	86	6.1	4.3		4.1	3.9	
- motel	yes	23	8.2	5.5	0.02	5.0	4.5	0.25
	no	67	5.6	3.9		3.8	3.8	
Neighbourhood damaged								
	yes/ unknown	27	7.5	5.7	0.10	4.9	4.7	0.24
	no	67	5.7	3.8		3.8	3.7	
Financial loss from lack of work	yes	27	7.0	4.7	0.07	4.8	4.1	0.06
	no	63	5.4	4.0		3.3	3.7	
Health problem immediately post fire								
	yes	30	7.6	4.3	0.06	5.0	4.0	0.13
	no	60	5.7	4.5		3.7	4.0	
Days between May 3rd at questionnaire								
	≤ 91 days	36	6.9	4.9	0.14	4.2	4.1	0.77
	92-182 days	54	5.4	3.7		4.0	3.9	
Overall		90	6.3	45		4.1	4.0	

Table 5: Factors related to anxiety and depression in multivariate regression models
(A)all variables entered together (B) stepwise in those evacuated (N=90)

A) All variables entered at one step

Variable	Anxiety		Depression	
	Beta	p=	Beta	p=
Male	-0.29	0.01	-0.20	0.07
Reception centre	0.12	0.22	0.04	0.73
Motel	0.25	0.01	0.09	0.43
Neighbourhood damage	0.10	0.32	0.11	0.34
Financial loss from work	0.15	0.15	0.21	0.06
Health problem post fire	0.11	0.27	0.12	0.30
> 90 days since fire	0.18	0.09	0.01	0.91

B) Variables entered stepwise with the most strongly related entered first

Variable	Anxiety		Depression	
	Beta	p=	Beta	p=
Male	-0.34	0.00	-0.21	0.04
Motel	0.31	0.00	-	-
> 90 days since fire	0.26	0.01	-	-
Financial loss from work	-	-	0.21	0.05

Appendix 1. Objectives and recruitment of the two existing cohorts.

A) Injury cohort

The cohort was recruited to test the feasibility of a prospective study of injuries among workers in the Fort McMurray area, to investigate whether interprovincial workers were more at risk of work place injury than those more established in Alberta and, if so, to examine possible reasons, including type of employment, extended working cycles, shift work patterns, living circumstances and training. As unreported injury is a matter of great sensitivity, with potential penalties for both worker and employer, it was essential that the participants did not disclose the name of the employer, and recruitment could not be carried out through work sites. As such, we used five recruitment strategies/sites. This were i) an independent clinic used by many employers for pre-employment screening ii) a social club used by many coming from one province (Newfoundland and Labrador) iii) the local technical college that provided a short occupational safety course that was a pre-requisite for working with the large oil and gas companies iv) the emergency department used by many out-of-province workers for minor medical issues v) on-line questionnaires completed by workers who had heard of the study from leaflets in the emergency department, in the social club or by word of mouth from other participants. To be eligible a potential participant had to be in paid employment in the Fort McMurray area or about to take up employment, and to be a Canadian or landed immigrant. Temporary foreign workers were not included. Workers who met these criteria and who agreed to be approached to complete a follow-up questionnaire were paid $50 on completion of the baseline questionnaire.

B) Trade cohort

Those in the trade cohort were recruited as part of a study of the effects of work in the welding and electrical trades on the health of the participant and, for women, the impact on the outcome of pregnancies that occurred while working in the trade. All participants were identified through the apprenticeship board (or equivalent) of the province in which they did their training. For women we recruited from across the country, with every province and territory collaborating, the largest number being recruited from Alberta. For men recruitment was restricted to Alberta, with a random sample of men in each trade being approached. The apprenticeship boards were asked to identify people in these trades who had started an apprenticeship since 2005 and to send out recruitment materials on our behalf. A total of 886 women and 997 men were recruited. They are followed for up to 5 years (women) or up to 3 years (men) completing further questions about health, pregnancies and work exposures every 6 months.

Appendix 2

Post-Fire Post-Follow-up Questionnaire

Name of Participant_____

Name of Interviewer: _____

DATE INTERVIEW COMPLETED: _____

FOLLOW-UP COMPLETED:

- ☐ On line
- ☐ By mail
- ☐ By telephone
- ☐ Face to face (please specify where:_____)

If by telephone or face-to-face,

TIME INTERVIEW STARTED: _____

TIME INTERVIEW ENDED: _____

Thank you for agreeing to share your experiences during and after the fire in the Fort McMurray Wood Buffalo area. This interview should only take between 5 and 10 minutes.

Part 2

This section is about events around the time of the fires in Fort McMurray, starting on May 2nd

6.1 Can you confirm that you were living or employed in the Fort McMurray/Wood Buffalo area in the time leading up to the fire?

Yes □ No □

If no, go to Part 3

If yes,

6.1.2 Were you actually in the Fort McMurray/Wood Buffalo area on Monday May 2nd?

Yes □ No □

If no, go to question 7.1

If yes,

6.2 Were you working or on days off on May 2nd?

Working □ Days off □ Other, namely_____

6.3 Were you living in a work camp on May 2nd?

Yes □ No □

6.4 Were you evacuated from the Fort McMurray/Wood Buffalo area during the period of May 2nd- 5th?

□ Evacuated from Fort McMurray/Wood Buffalo

□ Evacuated from a work camp due to smoke or fire precautions

□ Evacuated from a work camp due to site shut down

□ Not evacuated

If you were evacuated, go to question 6.4.3

If you were not evacuated,

6.4.1 Where were you living on those days?

_____ _____

(Town) (Province)

6.4.2 If **Fort McMurray/Wood Buffalo**, please explain (e.g. emergency worker, living in camp used as an evacuation centre etc…)

_____

_____

If you were evacuated,

6.4.3 Where did you go immediately after the fire:

- □ North to (specify town/work camp) _____
- □ South to (specify town/work camp) _____

6.4.4 Where did you sleep during the first couple days (choose all that apply)?

- □ Vehicle
- □ Trailer/RV
- □ Reception centre
- □ Motel/Hotel
- □ Work camp accepting evacuees
- □ With family or friends
- □ Own home (outside of Fort McMurray/the evacuated areas of Wood Buffalo)
- □ Emergency settlement with people you did not know previously
- □ Emergency settlement in a house/apartment that you had to yourselves
- □ Other, namely _____

6.5 During or immediately after the fire, did you experience any health problems caused or made worse by the fire?

Yes □ No □

If no, go to question 7.1

If yes,
6.5.1 Please describe

_____

6.5.2 Was this a new condition or an existing one made worse?

New condition □ Existing one made worse □

If this was a new condition, go to question 6.5.2.1

If this was an existing condition, go to 6.5.2.2

6.5.2.1 Does this condition bother you now?

Yes □ No □

6.5.2.2 Is this condition worse now than it was before the fire?

Yes □ No □

6.5.3 Did you see a physician for this?

Yes □ No □

If no, go to question 7.1

If yes,

6.5.3.1 When was the first time you saw a physician for this **since the fire started (since May 2nd, 2016)?**

_____Day_____Month _____Year

6.5.3.2 Where did you seek medical advice (report all that apply)?

□ Emergency department off-site
□ Walk-in clinic
□ Family physician office
□ Admitted to hospital
□ Other, please specify: _____

Part 3

This section is about your life now

Accommodation and Employment

7.1 Where are you living now?

_____ _____

(Town) (Province)

7.2 Are you now in the same accommodation as immediately prior to the fire?

Yes □ No □

7.3 Are you now living in:

□ A work camp

□ A motel/hotel

□ A trailer/RV

□ With family or friends

□ Own house or condo (live by self or with family)

□ House (rent a portion of / shared)

□ Temporary settlement in a house or apartment

□ Other, namely _____

7.4 Was your neighbourhood in Fort McMurray/Wood Buffalo badly damaged during the fire?

Yes □ No □ Don't know yet □

Had no accommodation in Fort McMurray/Wood Buffalo □

7.5 Was your home in Fort McMurray badly damaged during the fire?

Yes □ No □ Don't yet know □

No home in Fort McMurray/Wood Buffalo □

7.6 Did you suffer financial loss from property damage (home, vehicle, etc…) during the fire?

Yes □ No □ Don't know yet □

If no, go to question 7.7

If yes,

7.6.1 Please estimate how much loss from property damage (excluding any sum you received from insurance, provincial funding etc...)

$_____

Employment

7.7 Have you held any paid work since the fire?

Yes □ No □

If no, go to question 7.8

If yes,

7.7.1 Was this with the same employer as at the time of the fire?

Yes □ No □ Not working at the time of the fire □

7.7.2 When did you first get back to work?

_____ day _____ month _____ year

7.7.3 Please give details of each job you have held since the fire in the grid below

Type of job (what did/do you do)	Type of industry	Location (town, province or country)	Date started	Date left (or "still there")

7.7.4 Since May 1st have you had any injuries caused by work?

(this includes minor injuries or injuries that were not reported such as cuts, abrasions, painful strains or sprains)

Yes □ No □

If no, go to 7.8

If yes:

7.7.5 When was this injury? _____month _____year

7.76 Please tell us what happened? _____

_____

7.7.7 Was this injury reported to the WCB? Yes □ No □

7.8 Have you suffered financial loss through less work/no work since the time of the fire?

Yes □ No □

If no, go to question 8.3

If yes,

7.8.1 Please estimate how much loss you have suffered through working less since the fire:

$_____

8.3 We would like to ask you about how you have been feeling during the last week. Please check the box alongside the reply that is closest to how you have been feeling in the past week.

Don't take too long to think over your replies; your immediate answer is best.

I feel tense or 'wound up': □ Most of the time □ A lot of the time □ From time to time, occasionally □ Not at all	**I feel as if I am slowed down:** □ Nearly all the time □ Very often □ Sometimes □ Not at all
I still enjoy the things I used to enjoy: □ Definitely as much □ Not quite so much □ Only a little □ Hardly at all	**I get a sort of frightened feeling like 'butterflies' in the stomach:** □ Not at all □ Occasionally □ Quite often □ Very often
I get a sort of frightened feeling as if something awful is about to happen: □ Very definitely and quite badly □ Yes, but not too badly □ A little, but it doesn't worry me □ Not at all	**I have lost interest in my appearance:** □ Definitely □ I don't take quite as much care as I should □ I may not take quite as much care □ I take just as much care as ever
I can laugh and see the funny side of things: □ As much as I always could □ Not quite so much now □ Definitely not so much now □ Not at all	**I feel restless as if I have to be on the move:** □ Very much indeed □ Quite a lot □ Not very much □ Not at all
Worrying thoughts go through my mind: □ A great deal of the time □ A lot of the time □ Not too often □ Very little	**I look forward with enjoyment to things:** □ As much as I ever did □ Rather less than I used to □ Definitely less than I used to □ Hardly at all

I feel cheerful: □ Never □ Not often □ Sometimes □ Most of the time	**I get sudden feelings of panic:** □ Very often indeed □ Quite often □ Not very often □ Not at all
I can sit at ease and feel relaxed: □ Definitely □ Usually □ Not often □ Not at all	**I can enjoy a good book or radio or TV program:** □ Often □ Sometimes □ Not often □ Very seldom

Experiences with the fire

9.3 Would you choose to go back to work in Fort McMurray?

Yes □ No □ Currently working in Fort McMurray □

If no, Why not?_____

9.4 Do you hope to go back to Fort McMurray to live?

Yes □ No □ Currently living in Fort McMurray □

If no, Why not_____

9.5 Is there anything else you would like to tell us about the way the fire has affected your life?

_____

_____

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract Done
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Done
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Done
Objectives	3	State specific objectives Done
Methods		
Study design	4	Present key elements of study design early in the paper Done
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Done
Participants	6	*(a)* Give the eligibility criteria, and the sources and methods of selection of participants. Done in Appendix 1 b) Describe methods of follow-up Done
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Done
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Done, including questionnaire as Appendix 2
Bias	9	Describe any efforts to address potential sources of bias None identified
Study size	10	Explain how the study size was arrived at As described – determined by pre-existing cohorts
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Done
Statistical methods	12	*(a)* Describe all statistical methods, including those used to control for confounding *(b)* Done
		(c) Describe any methods used to examine subgroups and interactions *(d)*
		(b) Explain how missing data were addressed *(c)* Done
		(*d*) If applicable, explain how loss to follow-up was addressed

		(d)	Describe any sensitivity analyses
		(e)	Not applicable
Results			
Participants	13*	(a)	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b)	Done
		(c)	Give reasons for non-participation at each stage
		(d)	Done
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a)	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b)	Done
		(b) Indicate number of participants with missing data for each variable of interest	
		(c)	Summarise follow-up time (eg, average and total amount)
		(d)	Done
Outcome data	15*	Report numbers of outcome events or summary measures over time Done	
Main results	16	*(a)*	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(b)	Done with univariate analysis shown for all factors passing screening criterion of $p<0.10$
		(c)	Report category boundaries when continuous variables were categorized
		(d)	Done
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives Done	
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Done	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Done	
Generalisability	21	Discuss the generalisability (external validity) of the study results Done	
Other information			

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based Done

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.